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# CRITERIA FOR REDUCING COMPLIANCE-BASED AIR QUALITY MONITORING REQUIREMENTS FOR ZONAL AIR QUALITY MANAGEMENT IN ALBERTA

Alberta
ENVIRONMENT

# CRITERIA FOR REDUCING COMPLIANCE-BASED AIR QUALITY MONITORING REQUIREMENTS FOR ZONAL AIR QUALITY MANAGEMENT IN ALBERTA

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# SUMMARY

Available information on reducing compliance-based air quality monitoring stations from Alberta Environment and on zonal air quality management from the Clean Air Strategic Alliance and the Zonal Management Associations has been reviewed. Ambient monitoring requirements were reduced after considering many factors by Alberta Environment from industrial facilities with zero or "few" public complaints and with zero or "few" exceedances above the ambient air quality guidelines. This was possible only when "adequate" zonal networks were designed and operated by the zonal Associations. Such a procedure should continue for any new zones.

There are no completely objective criteria to determine what should be the acceptable number of "few" public complaints or "few" ambient air quality exceedances. A subjective assessment and procedure to determine the acceptable level of "few" ambient exceedances above the guidelines for reducing compliance-based ambient stations is suggested, which is based on different factors. Alberta Environment may use these suggested criteria on an interim basis and revise it in the light of input from stakeholders. Zonal monitoring networks are going to be somewhat different from each other due to regional characteristics, local issues, financial resources, air emissions and the impacts on the receptors.

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## 1.0 INTRODUCTION

The current air quality management system used by the Alberta Government has evolved over the years. The key components of the system include: ambient guidelines; source emission standards; plume dispersion modelling; ambient and source emission monitoring; environmental reporting; emission inventories; approvals; inspections; abatement; enforcement, and research. This system was designed to ensure that the emissions are minimized at the source and that the ambient air quality meets Alberta's air quality objectives (Macdonald and Bietz, 1996).

In the late 1980's, the Government of Alberta recognized new local and global challenges on air issues and launched the development of a Clean Air Strategy for Alberta (CASA). Subsequently, the government endorsed a clean air vision for Alberta (CASA 1991; Legge et al., 1992):

> "*The air will be odourless, tasteless, look clear and have no measurable short- or long-term adverse effects on people, animals or the environment.*"

In 1994, the Clean Air Strategic Alliance of Alberta (also CASA) was formed and incorporated with representatives from government, industry and non-government organizations. The overarching goal of the Alliance is to develop an air quality management system for Alberta with the specific mandate to: 1) clearly identify the most important air quality issues; 2) prioritize specific problems; 3) allocate and coordinate resources; 4) develop solution oriented action plans, and 5) evaluate results. CASA provides an excellent forum for multistakeholder consultation on air issues. It has also provided leadership in setting up various zones for air quality management in Alberta, and has published guidelines (CASA, 1995). Three air quality management zones in Alberta are already functioning and will be discussed in a later section (Figure 1).

### 1.1 Project Terms of Reference

1. Meet separately in person or make contact by telephone with some representatives of Alberta Environment, Clean Air Strategic Alliance, West Central Airshed Society, Wood Buffalo Environmental Association and Parkland Airshed Management Zone.

2. Compare the zonal network's ambient monitoring provisions relative to their stated objectives and the compliance-based network they were intended to replace.

3. Provide a comparative assessment of the zonal network and the compliance-based stations in meeting the Clean Air Strategic Alliance and the Alberta Environment objectives.

4. Develop and recommend criteria and/or an assessment procedure that may be applied to future proposals for zonal networks, for decisions about reducing compliance-based ambient monitoring stations.

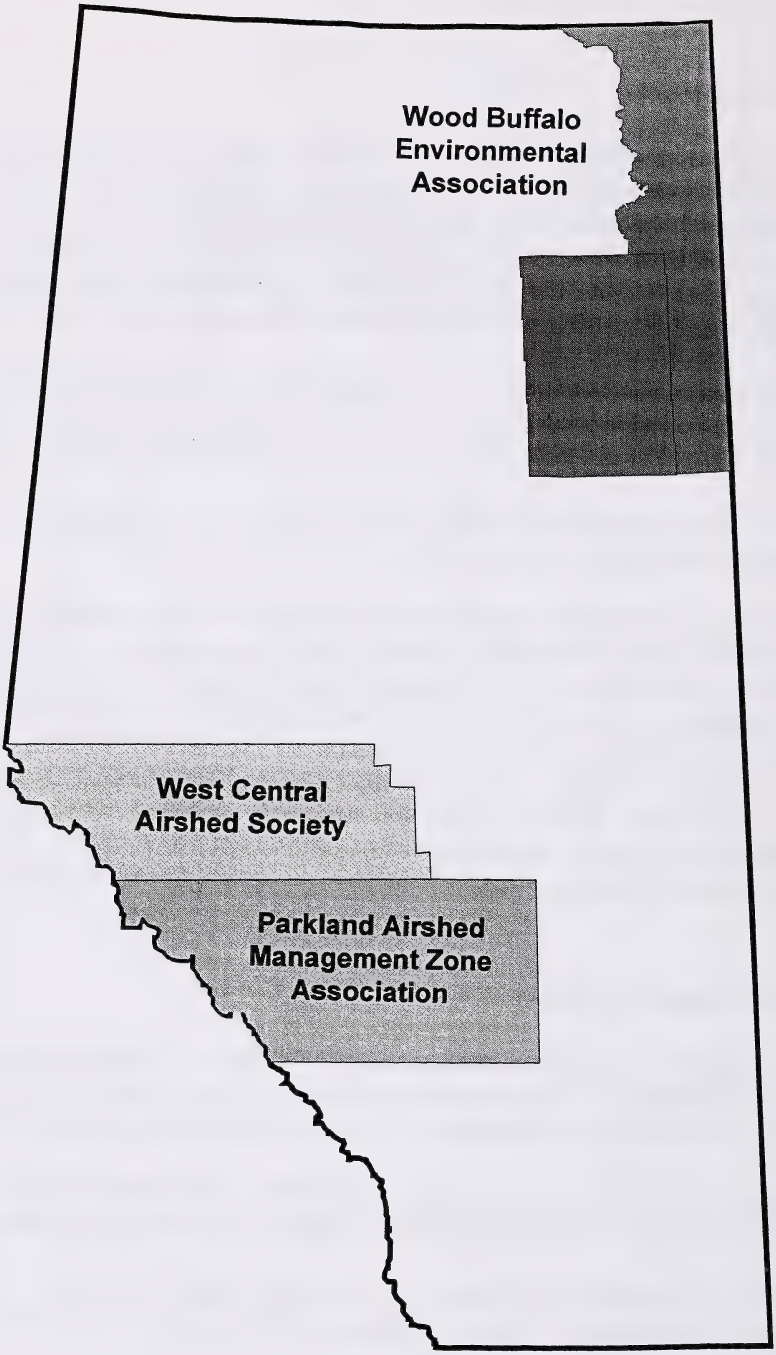

**Figure 1** **Current airshed management zones in Alberta (CASA, 1999)**

## 2.0 MONITORING PURPOSES OF ALBERTA ENVIRONMENT

An important part of Alberta Environment's overall regulatory program is the compulsory source and ambient monitoring that industry is required to undertake. This monitoring serves a number of purposes and assists both industry and government. There are no separate specific objectives for ambient air quality monitoring. Alberta Environment's overall monitoring program:

1. provides a measure of performance relative to established limits, standards or guidelines;
2. ensures that pollution control technologies are operating effectively;
3. provides an early warning system for potential contamination issues;
4. characterizes complex emissions to determine potential environmental impacts;
5. provides information for provincial and national emission inventories that are used in environmental management;
6. assesses the impact of releases on the environment, and
7. provides data for tracking trends in environmental performance and effects.

These are general purposes for monitoring source emissions as well as ambient monitoring of the concentration of contaminants in the air, land and water components of the environment. Further specific monitoring requirements, including quality assurance and quality control, are specified in approvals, issued pursuant to the *Environmental Protection and Enhancement Act.* In summary, the purposes of compliance-based industry monitoring are to obtain reliable data on the environmentally-related performance and environmental impacts of industrial operations. The government developed a process for reducing the number of compliance-based ambient monitoring stations at the request of industry, provided the performance was satisfactory (ERCB, 1979).

# 3.0 CLEAN AIR STRATEGIC ALLIANCE (CASA) GUIDELINES

The Clean Air Strategy for Alberta included goals related to better management of point sources and development of zones in Alberta (CASA, 1991). During the strategy development, it was noted that the existing emission monitoring and control programs were focused on industrial point sources, rather than airsheds or larger regional zones. This emphasis created the potential for increase in emissions despite compliance with regulations by individual facilities. An improved means of achieving environmentally sustainable loadings of pollutants of concern, both within and outside of provincial boundaries, was needed. This thinking lead to the concept of managing air quality on both point source and zone basis. One of the goals related to point source was to strengthen the management approach for all point source emissions in Alberta in order to avoid adverse effects on human health and the environment. The key zone goal was to develop and implement a zone approach to managing air quality within specific airsheds in Alberta. It was also recognized that the ambient air quality monitoring programs needed to be coordinated and integrated for this new management approach, including efficient use of available resources.

The Clean Air Strategic Alliance is responsible for strategic planning related to air quality issues. To guide this process, the Alliance endorsed a Comprehensive Air Management System (CAMS) for the province. Under this system, zones can be established as a means of dealing with air quality issues in a specific region. Guidelines were issued by CASA as to when zones are appropriate, how they might be established, and what alternatives exist (CASA, 1995). It was made clear in the guidelines that zones would be defined on the basis of emission sources and volumes, dispersion characteristics, impacts, and administrative characteristics. Moreover, stakeholders involved in the zone should follow the vision and principles of the Clean Air Strategy of Alberta. It was also emphasized in these guidelines that the decision-making process for zone stakeholders will be based on the CASA process of collaboration and consensus. If consensus can not be reached, areas of disagreement, along with explanations of the various interests involved in the disagreement, will be referred to the Alliance Board for decision.

## 4.0 PURPOSES/OBJECTIVES OF CURRENT AIRSHED ZONES

Once a decision is made by the stakeholders to establish a zone, the responsibilities for developing the management system and plan are allocated. CASA suggested following steps to be part of developing such a plan (CASA, 1995).

1. establishing goals
2. defining options and setting objectives or targets
3. assessing and selecting options
4. preparing implementation plans, and
5. evaluating success.

Additional work may be required in any or all of these areas:

6. assessing impacts
7. monitoring ambient air quality
8. compiling emission inventories
9. modelling air quality, and
10. examining trends

So far, the three airshed management zones of West Central, Wood Buffalo and Parkland have been established (Figure 1). CASA guidelines were followed closely in establishing these zones. During early meetings to form a zone in each of the three regions, stakeholders discussed differences and benefits in moving from compliance-based monitoring to zonal airshed monitoring. Table 1 includes information on differences in current and zonal monitoring system for Parkland (PAMZ, 1999b). The purposes/objectives of the three zones are compared in Table 2. These are very similar and only reflect regional differences. Any other minor differences in wording reflects the evolutionary nature of their development. The zone purposes/objectives are also consistent with Alberta Environment's general purposes for monitoring, given in Section 3.0.

**Table 1** **Differences in current and zonal monitoring system in Parkland (PAMZ, 1999b)***

| Current System<br>(Compliance Driven) | Zonal System<br>(Issue Driven) |
|---|---|
| Monitors are point source located | Monitors located in areas of high deposition based on modelling and portable unit available to respond to local issues |
| No portable monitoring | Portable monitoring |
| Inconsistent quality assurance and quality control program | Consistent quality assurance and quality control program to validate data |
| Measures minimum of parameters – inconsistent with provincial system | Measures more parameters to assess air quality in zone – consistent with provincial system |
| Monitoring of parameters may be at detection levels too high to be useful | Monitoring of parameters at lower and more useful detection level |
| Poor communication of monitoring results and methods | Better communication of monitoring results and methods |
| "Unequal" system – select sources of emissions contribute to monitoring | "Fairer" system – all stakeholders contribute and share in benefits |
| Provides no data to assess trends in air quality | Provides data to assess trends in air quality |
| Difficult to expand monitoring system | Easy to expand monitoring system |
| Difficulty in responding to local issues and concerns | Designed to readily respond to local issues and concerns |
| Ineffective utilization of resources | Effective utilization of resources |

*Some wording is modified.

**Table 2 Purposes/objectives of existing airshed zones**

| Wood Buffalo | West Central | Parkland |
|---|---|---|
| 1. Promote and foster cooperative effort among government, community, aboriginal groups and industry directed at establishing and maintaining a program for environmental monitoring and research in the Wood Buffalo Region of Alberta.<br>2. Generate research and development projects, including application of traditional knowledge and expertise, to ensure that environmental protection practices used by resource developers can be implemented effectively.<br>3. Establish and maintain a program for environmental monitoring and research in the Wood Buffalo Region.<br>4. Act as a liaison among industry, government, aboriginal groups, communities and the public in matters pertaining to the monitoring of environmental conditions.<br>5. Cooperate with government, aboriginal groups and the public in establishing needs and priorities pertaining to the monitoring of environmental conditions. | 1. Provide a forum for discussion and coordination of matters related to the management of an airshed monitoring and management program for the Zone. Monitoring programs will be designed to identify and quantify air quality concerns and the Board will develop and implement options to address concerns identified.<br>2. Promote understanding between the Society, governments, stakeholders, the public, other airshed zones and other organizations about environmental impacts of activities inside and outside the airshed in regard to air quality within the airshed.<br>3. Identify and quantify on a credible basis air quality concerns, and use the data to recommend and implement airshed management solutions for the zone.<br>4. Coordinate and integrate airshed monitoring and management activities within the Zone with the provincial policies and guidelines as developed by the Clean Air Strategic Alliance (CASA), and/or Provincial air quality stakeholders in their respective areas of authority. | 1. Identify air quality problems and respond to air quality issues and concerns within the zone boundaries.<br>2. Establish, in synchronization with current provincial CASA initiatives, a regional system to monitor air quality and the impact of emissions on the environment.<br>3. Identify emission sources and establish a fair funding formula whereby emitters contribute in proportion to their share of emissions produced.<br>4. Establish a communication program to obtain input and to inform and involve the public.<br>5. Integrate with other zones and the provincial air quality management system. |

## 5.0 SOME ZONAL PARAMETERS AND AIR QUALITY MONITORS

Some information on zonal parameters and types of air quality monitors is compared in Table 3. It is suffice to mention that the area and emissions are different in each zone. The current number of continuous monitors are maximum in Wood Buffalo and minimum (proposed) in Parkland, whereas passive monitors are maximum in Parkland zone and minimum in West Central. This variation partly reflects the economic factors, as well as the nature of emissions and objectives of the ambient monitoring program. Some of the compliance-based monitoring is part of the Wood Buffalo zone, but not part of the West Central zone program.

During the conversations with different individuals in the course of this study, a question was raised as to “What number of combined continuous and passive stations constitutes an adequate network for zonal air quality monitoring?”. This question of monitoring design has been addressed by many authors over the years (Calder, 1975; Munn, 1981 and Sakiyama, 1989). The general considerations on this topic have been summarized for Alberta Environment by Sakiyama (1989).

Calder (1975) stated that “the design of air quality networks is an exceptionally difficult and subtle problem that continues to be of major importance”. Decisions related to site selection, measured parameters and duration are all bounded by legal, economic, technical, personnel and time constraint factors. The most difficult decisions relate to the number and location of monitors (adequacy). Two basic approaches are used to simplify this difficult process - statistical and modelling.

To the author's knowledge, all three zones compiled emission inventories and undertook modelling to locate air quality monitors. Any additional adjustments in the number and location of monitors must have been either due to the factors mentioned above or due to a variation in the zone management philosophy.

**Table 3** **Comparison of some zonal parameters and activities**

| Parameter | Wood Buffalo | West Central | Parkland |
|---|---|---|---|
| Area (approx.) ($km^2$) | 68,500 | 35,000 | 40,000 |
| Emissions (1998) (tonnes) | | | |
| - $SO_2$ | 87,965 | 24,700 | 57,047 |
| - $NO_x$ | 30,000 | 27,200 | 41,916 |
| Monitoring Program Start-up | November 1997 | January 1996 | December 1999 |
| Current Ambient Monitors | | | |
| - Continuous* (air quality) | 3 super<br>4 normal<br>1 background | 1 super<br>3 normal<br>1 background | 2 super<br>1 mobile super (start-up in early 2000) |
| - Passive** (air quality) | 12 | 2 | 28 |
| Sampling Frequency | bimonthly in winter, monthly in summer | biweekly in summer only | monthly all year round |
| - Receptor (biomonitoring) | soil, vegetation and animal tissue | forests, vegetation and soils | none |
| High Priority<br>- Issues (3) | - human health<br>- odours<br>- data management | - soil acidification<br>- crops and forests<br>- human health | - human health<br>- animal health<br>- flaring |

* Air quality and meteorological parameters measured, as well as detection limits for various air pollutants, may be different in each zone. See the zone annual reports for details.

** Monitors $SO_2$, $NO_x$ and $O_3$.

## 6.0 CRITERIA FOR REDUCING COMPLIANCE-BASED STATIONS WHEN ESTABLISHING A ZONAL AMBIENT MONITORING SYSTEM

Alberta Environment set a precedent on the procedure for reducing compliance-based stations from sour gas industrial facilities in the West Central zone in 1994. The Department considered eight factors listed in Table 4 (AEP, 1994). Two main factors used to reduce stations were (1) historical ambient data, and (2) public complaints. This was a subjective decision as no objective criteria were available at that time or now. Analyses of information from the operating plants were carried out and decisions were made on the monitoring status to keep or remove station(s). Though the information from static and continuous monitors was analyzed, it appears that the number of ambient one-hour air quality exceedances above Alberta guidelines for sulphur dioxide and hydrogen sulphide played a major role in decision-making. It was noted from the analyses of the 1984 to 1993 data that the number of hourly ambient exceedances per sour gas plant varied from 0 to 3 and 0 to 35 for sulphur dioxide and hydrogen sulphide, respectively.

For one case, a decision was made to keep a station when there were 3 sulphur dioxide and 15 hydrogen sulphide exceedances for a large point source with a history of exceedances. However, for another case, a decision was made to remove monitoring station(s) from a facility with 35 hydrogen sulphide exceedances and with no sulphur dioxide exceedances because the plant had no recent problems. In a complex situation where many factors need to be considered, such a subjective judgement is necessary.

When establishing a zonal monitoring system, the Department should continue to review and analyze all available information and data, at least for the last five years, for each existing industrial facility which falls in a proposed zone for factors listed in Table 4. For new facilities this duration will be less than 5 years. Average value per year for each of the factors should be determined, such as number of public complaints per year, number of exceedances per year above the provincial ambient guidelines, and the annual mean ambient concentration for each pollutant. Once this is done, the following criteria are suggested to reduce, remove or keep existing compliance-based air quality monitoring stations. This will help the Department to keep procedures consistent from zone to zone.

1. The industrial facility should have performed its operations over the years in a manner acceptable to Alberta Environment and Alberta Energy and Utilities Board. Is the number of plant upsets per year high or low and what is the trend over the last 5 years?

2. The total amount of current and projected emissions of pollutants should be considered. Are the emissions high or low? Actual emissions from a facility of a criteria pollutant of 20 tonnes per day or more are considered high.

**Table 4 Factors considered by Alberta Environment to reduce compliance-based ambient monitoring requirements from the sour gas industry in the West Central Zone for zonal air quality management***

| No. | Factor | Remarks |
|---|---|---|
| 1 | Operating History of Facility – Receptor Monitoring | Ambient Monitoring Data – Continuous<br>• readings over $H_2S$ guideline (one-hour and 24-hour)<br>• readings over $SO_2$ guideline (one-hour and 24-hour)<br>• readings approaching guideline levels<br><br>Ambient Monitoring Data – Static<br>• readings over total sulphation guideline level (i.e. 0.5 $SO_3$ equivalent mg/day/100 $cm^2$)<br>• readings over $H_2S$ guideline level (i.e. 0.1 $SO_3$ equivalent mg/day/100 $cm^2$)<br>• readings over dustfall guideline level<br><br>Soil Monitoring Data<br>• assess for apparent trends (i.e. acidification) |
| 2 | Operating History of Facility – Continuous Stack/Survey | • expected Maximum Ground Level Concentration (MGLC) for $SO_2$ emissions based on design/rated inputs<br>• stack Continuous Emissions Monitoring System (CEMS) readings in excess of approval limit for $SO_2$<br>• stack readings approaching stack limits<br>• yearly totals of stack emissions (trend?) |
| 3 | Operating History of Facility – Production | • history of production throughput and sulphur inlet rate |
| 4 | Potential for Facility Expansion | • short term (i.e. < 3 years)<br>• long term (i.e. ≥ 3 years) |
| 5 | Complaint History in Area of Facility | • total complaints<br>• validated complaints<br>• does ambient monitoring help in resolving complaint situation? |
| 6 | Local Sensitivities | • are there special impact factors that need to be assessed in the area of the facility (i.e. sensitive vegetation, persons with asthma, etc.)? |
| 7 | Overall Assessment of Pollutant Impact Potential | |
| 8 | Availability of Other Monitoring Networks/Programs in Area | |

* Table taken from reference (AEP, 1994)

3. Number of public complaints per year relating to ambient air quality should be zero or "few". What is the trend in public complaints over the last 5 years? A determination should be made by the Department as to what number constitutes "few" after considering validity and severity of complaints.

4. The Department should ensure that the proposed zonal air quality monitoring network is "adequate". As a minimum, below are listed some points which should be considered to determine adequacy. The proposed monitoring network should:

   i. cover a widespread area of the zone and not just part of the zone;

   ii. include areas with industrial facilities that have a history of plant upsets and/or high emission events;

   iii. employ monitoring methodologies and procedures that yield accurate and scientifically credible data for pollutants of concern;

   iv. produce data and information to deal with zonal ambient air quality complaints;

   v. attempt to produce data on the type and amount of pollutants entering and leaving the zone;

   vi. generate results that can be compared with Alberta's ambient air quality guidelines to indicate quality of the zone air, and

   vii. include air quality monitoring stations in the zone that have been designated as part of the provincial monitoring network of stations.

5. The Department should consider the trend and the number of ambient exceedances per year (from the current compliance-based ambient monitors in a proposed new zone) above the Alberta ambient air quality guidelines for each pollutant. The exceedances should be zero or "few". A subjective procedure for determining acceptable level of "few" exceedances per year, considering five factors, is described in the next section.

6. If an industrial facility is generating emissions that are not going to be monitored by the proposed zonal network, compliance-based ambient monitoring for that facility should continue.

7. Alberta Environment needs to review the zonal ambient air quality data on a continuing basis to ensure that the Department's monitoring purposes are met and the public is satisfied with the zonal monitoring.

## 7.0 PROCEDURE TO DETERMINE ACCEPTABLE LEVEL OF AMBIENT EXCEEDANCES

As mentioned in the last section, a procedure to determine acceptable level of "few" ambient exceedances is described here. This is based on the review of the available information from the current zones, from Alberta Environment, input from individuals contacted, and the author's professional knowledge. It is assumed that Alberta's ambient air quality guidelines for all criteria air pollutants are equally important and that the designed zonal network is "adequate" and acceptable to Alberta Environment.

The dictionary meaning of the word "few" is - some and not many. In the present context, the word "few" is assigned a maximum value of five, subjectively. This is a maximum value for the total number of acceptable ambient air quality exceedances per year above the Alberta guidelines, to reduce compliance-based ambient air quality stations from a facility, based on the evaluation of five factors listed below.

All these factors are assumed to be equally important and given equal weight of plus or minus to keep the procedure simple. It must be emphasized again that this method is a subjective one and there are no ways to make it objective. The factors that need to be considered for each criteria air pollutant are:

1. Annual Mean Ambient Concentration and Deposition: Annual mean ambient concentration and deposition are less than one-half value of a guideline (plus) or more (minus);

2. Annual Maximum Ambient Concentration and Meteorology: Annual maximum ambient concentration is close to the guideline (plus) or more than double the guideline (minus) under normal meteorological conditions;

3. Ambient Monitoring Duration and Type: Ambient monitoring is for a full year with continuous monitors (plus) or is less than a year with passive monitors (minus);

4. Public Complaints and Plant Upsets: Public complaints and plant upsets are low (plus) or high (minus). Alberta Environment needs to determine what number constitutes high public complaints and plant upsets, and

5. Total Emissions and Terrain: Total emissions from a facility are low and the surrounding terrain is simple (plus) or total emissions are high and the terrain is complex (minus). Total actual emissions of a criteria air pollutant of 20 tonnes per day or more from a facility are considered high.

As stated earlier, the plus and minus words in the parentheses indicate a positive or a negative weight for that factor. If all the above five factors for a specific pollutant have negative weights (minus 5), no exceedances per year are acceptable to remove an existing compliance-based station from a facility. On the other hand, if all five factors have positive weights (plus 5), a maximum of five ambient exceedances per year are acceptable to remove a station. The intermediate situations of factors with one plus (four minus) to four plus (one minus) are assigned maximum acceptable exceedances values of one to four, respectively. Assignment of a different weight to each of the above factors will change the number of acceptable exceedances.

Such simple determinations should be carried out for all criteria pollutants of concern to determine whether to keep, remove or reduce compliance-based monitoring stations for zonal air quality management. The above procedure appears to be the simplest method of determining what constitutes the number of acceptable "few" exceedances. Other factors, such as age of facility or sensitivity of ecosystems, can be included in the above factors. This procedure is not specific to any specific type of industrial facility. As the above suggested procedure is subjective, stakeholders' input in determining the final values for an acceptable number of "few" ambient air quality exceedances and "few" public complaints is desirable.

## 8.0 RECOMMENDATIONS

1. The Department may use the suggested criteria on an interim basis, and seek further input from the Clean Air Strategic Alliance and the current Zonal Airshed Management Boards for revising it.

2. The Department should publish the final criteria for distribution, and also give it to the stakeholders interested in forming a zonal airshed management association or a society.

3. The Department should arrange a meeting of appropriate staff from all Departmental Regions to determine what constitutes "few" acceptable public complaints and an "adequate" zonal monitoring network for reducing compliance-based stations.

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